

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	§	
Chellappa Balan	§	Group Art Unit: 1745
	§	
Serial No.: 10/731,373	§	Examiner: Yuan, Dah Weld
	§	
Filed: December 9, 2003	§	Confirmation No.: 4420
	§	
For: SYSTEM AND METHOD FOR	§	Atty. Docket: 132814-1/YOD
CO-PRODUCTION OF	§	GERD:0067
HYDROGEN AND	§	
ELECTRICAL ENERGY	§	

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April 14, 2008 Date	/Patrick S. Yoder/ Patrick S. Yoder

**APPEAL BRIEF PURSUANT TO 37 C.F.R. §§ 41.31 AND 41.37**

This Appeal Brief is being filed in furtherance to the Notice of Appeal mailed on February 13, 2008, and received by the Patent Office on the same day.

The Commissioner is authorized to charge the requisite fee of \$510.00, and any additional fees, which may be necessary to advance prosecution of the present application, to Account No. 07-0868, Order No. 132814-1/YOD (GERD:0067).

1. **REAL PARTY IN INTEREST**

The real party in interest is General Electric Company, the Assignee of the above-referenced application by virtue of the Assignment to General Electric Company, by Chellapa Balan, recorded at reel 014785, frame 0302, and dated December 9, 2003. Accordingly, General Electric Company, as the parent company of the Assignee of the above-referenced application, will be directly affected by the Board's decision in the pending appeal.

2. **RELATED APPEALS AND INTERFERENCES**

Appellant is unaware of any other appeals or interferences related to this Appeal. The undersigned is Appellant's legal representative in this Appeal.

3. **STATUS OF CLAIMS**

Claims 1-2, 4-10, 13-17 and 19-35 are believed to be currently pending. Claims 1-2, 4-10, 13-17 and 19 are currently under final rejection and, thus, are the subject of this Appeal. Claims 20-35 were withdrawn and claims 11-12, 18 and 36-41 were earlier canceled. Appellants intended to cancel claims 3 in the response to the Final Office Action filed on January 14, 2008. It is believed that this claim should be considered canceled (*see* Section 4 below).

4. **STATUS OF AMENDMENTS**

An amendment was filed which only canceled claim 3 in response to the Final Office Action. Although in the Advisory Action mailed on January 30, 2008, the Examiner indicated that the amendment would not be entered in case of Appeal, the Examiner also did not list claim 3 as pending. Accordingly, it is believed that the amendment was in complete conformance with the applicable rules, should have been entered and was entered.

5. **SUMMARY OF CLAIMED SUBJECT MATTER**

The present invention relates to hydrogen-based energy generation systems and more particularly to co-production of hydrogen and electrical energy utilizing integrated power generation systems. *See*, Application, paragraph 1.

The Application contains 1 independent claim – claim 1, and dependent claims 2, 4-10, 13-17 and 19, all of which are the subject of this Appeal. The subject matter of these claims is summarized below.

With regard to the aspect of the invention set forth in independent claim 1, discussions of the recited features of claim 1 can be found at least in the below cited locations of the specification and drawings.

By way of example, FIG. 1 illustrates a system (100) for co-production of hydrogen (28) and electrical energy comprising: a fuel cell assembly (18) comprising a plurality of fuel cells, the fuel cells further comprising a cathode inlet (6) for receiving a compressed oxidant (42), an anode inlet (2) for receiving a fuel feed stream (16), an anode outlet (4) in fluid communication with an anode exhaust stream (20) and a cathode outlet (8) in fluid communication with a cathode exhaust stream (44). At least a portion of the fuel feed stream (16) reacts with the oxidant to produce electrical power. The anode exhaust stream (20) comprises hydrogen, carbon monoxide, carbon dioxide, unreacted fuel and water. A separation unit (24) is in fluid communication with the fuel cell assembly (18). The separation unit is configured to receive the anode exhaust stream (20) from the fuel cell assembly (18) to separate hydrogen (28) from the anode exhaust stream (20). The separation unit (24) comprises a moisture separator to separate water (30) from the anode exhaust stream (20). A recycle stream (32) is provided in which at least a portion of the anode exhaust stream is recycled back to the anode inlet (18) after separation of hydrogen, carbon monoxide, carbon dioxide, unreacted fuel and water. *See, e.g., id.*, paragraph 18, 19, 21, 22, 25, 41, 42.

A benefit of the invention, as recited in these claims, is the ability to provide a system for co-production of hydrogen and electricity. The system provides for the flexibility to control the production of hydrogen from the anode exhaust stream and the generation of electricity depending on demand. For higher demand of exported hydrogen, the fuel cell assembly is operated in low utilization mode wherein the anode exhaust stream comprises higher amounts of unutilized hydrogen.

6. **GROUND OF REJECTION TO BE REVIEWED ON APPEAL**

**First Ground of Rejection for Review on Appeal:**

Whether the Examiner satisfied the burden of establishing a *prima facie* case that claims 1, 3-9, 15 and 19 are unpatentable over Farooque (U.S. Patent No. 5,084,362, hereinafter “Farooque”) in view of Nakamura et al. (U.S. Patent No. 7,052,790, hereinafter “Nakamura”).

**Second Ground of Rejection for Review on Appeal:**

Whether the Examiner satisfied the burden of establishing a *prima facie* case that claims 1-4, 6-8, 10, 15, 17 and 19 are unpatentable over Ukai et al. (U.S. Publication No. 2003/0035983, hereinafter “Ukai”) in view of Take (U.S. Publication No. 2004/0229092, hereinafter “Take”) and Nakamura.

**Third Ground of Rejection for Review on Appeal:**

Whether the Examiner satisfied the burden of establishing a *prima facie* case that claims 13-14 and 16 are unpatentable over Farooque and Nakamura in further view of Sridhar et al. (U.S. Publication No. 2004/0202914, hereinafter “Sridhar”).

**Fourth Ground of Rejection for Review on Appeal:**

Whether the Examiner satisfied the burden of establishing a *prima facie* case that claims 13 and 14 are unpatentable over Ukai and Take in further view of Sridhar.

7. **ARGUMENT**

As discussed in detail below, the Examiner has improperly rejected the pending claims. Further, the Examiner has misapplied long-standing and binding legal precedents and principles in rejecting the claims under Section 103. Accordingly, Appellant respectfully requests full and favorable consideration by the Board, as Appellant strongly believes that claims 1-2, 4-10, 13-17 and 19-35 are currently in condition for allowance.

A. **Legal Precedent and Guidelines:**

The burden of establishing a *prima facie* case of obviousness falls on the Examiner. *Ex parte Wolters and Kuypers*, 214 U.S.P.Q. 735 (B.P.A.I. 1979). Obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention absent some teaching or suggestion supporting the combination. *ACS Hospital Systems, Inc. v. Montefiore Hospital*, 732 F.2d 1572, 1577, 221 U.S.P.Q. 929, 933 (Fed. Cir. 1984). Accordingly, to establish a *prima facie* case, the Examiner must not only show that the combination includes all of the claimed elements, but also a convincing line of reason as to why one of ordinary skill in the art would have found the claimed invention to have been obvious in light of the teachings of the references. *Ex parte Clapp*, 227 U.S.P.Q. 972 (B.P.A.I. 1985). When prior art references require a selected combination to render obvious a subsequent invention, there must be some reason for the combination other than the hindsight gained from the invention itself, i.e., something in the prior art as a whole must suggest the desirability, and thus the obviousness, of making the combination. *Uniroyal Inc. v. Rudkin-Wiley Corp.*, 837 F.2d 1044, 5 U.S.P.Q.2d 1434 (Fed. Cir. 1988).

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prior art to deprecate the claimed invention. *In re Fine*, 837 F.2d 1071, 5 U.S.P.Q.2d 1596 (Fed. Cir. 1988).

B. **Ground of Rejection No. 1:**

The Examiner rejected claims 1, 3-9, 15 and 19 under 35 U.S.C. § 103 (a) as being unpatentable over Farooque in view of Nakamura.

Independent claim 1, recites a system that directs the anode exhaust to a separation unit, the separation unit including moisture separator. A portion of the anode exhaust is recycled back to anode inlet.

Farooque describes a system with a molten carbonate fuel cell that has a separates sends anode exhaust through a separator. The Examiner has combined this with Nakamura, which describes moisture separation from both anode exhaust and cathode exhaust. It is Appellant's position that the hypothetical combination is missing features of current invention.

1. **The hypothetical combination is structurally different from the system described by independent claim 1.**

Farooque, as shown in FIG. 1 of the reference teaches an anode exhaust stream 4 that is sent through a hydrogen separation and recovery device 8, and then as stream 15 to the gasifier. *See* Farooque, page 3, lines 4-12. It is clear that the *hydrogen stream is not recycled to the anode inlet as taught by claim 1.*

Combining Farooque with Nakamura to include condensers for moisture from the anode exhaust, does not overcome this deficiency. The system after *hypothetical combination* is still *structurally different* than system described by claim 1.

The hydrogen stream 15 of Farooque flows to gasifier 5, where a methane gas is produced. The methane gas, after undergoing cleaning and expansion, is sent to a molten

carbonate fuel cell. Presumably, on this ground, the Examiner seems to have assumed that the recycle to gasifier and fuel cell is same. It should be noted that the *hydrogen stream is materially changed* to methane in the gasifier. However, the recycling of hydrogen to a gasifier and recycling to a fuel cell (anode inlet) are not the same.

Nakamura describes a fuel cell system that separates moisture from the anode and cathode exhausts. Thus, any hypothetical combination of Nakamura and Farooque, does not overcome the deficiency that the system does not recycle a portion of anode exhaust stream to a fuel cell (anode inlet).

2. **The proposed combination of references does not obviate deficiency in Farooque.**

Farooque, on page 3, lines 4-12, mentions that the hydrogen from recovery device 8 is combined with steam 18, to be sent back to the gasifier. This is also corroborated by FIG. 1. The Examiner, when combining Farooque and Nakamura argued that:

[i]t would have been obvious to one of ordinary skill in the art to use to add a condenser downstream of the fuel cell system of Farooque, because Nakamura teaches use of the condenser to condense the content water vapor in the exhaust.

See Final Office Action dated November 14, 2007, page 5.

If such condensers were to be incorporated, the system of the hypothetical combination would remove water content from anode exhaust as suggested above lines, and before being recycled back, it would be mixed with steam 18 (*i.e.*, water vapor). This is the only fair reading of the teachings of Farooque and the only apparent way the system could operate consistent with those teachings.

In effect, the hypothetical combination removes water from the stream in water form, from the condenser, and again adds it in vapor form through stream 18. Not only

this is unnecessary, but this also does not remove the primary deficiency in Farooque that there is no recycling to the fuel cell.

3. **Farooque and the hypothetical combination of references teach away from features of claim 1.**

Independent claim 1, recites *inter alia*, a recycle stream in which at least a portion of the anode exhaust stream is recycled back to anode inlet *after separation of hydrogen*, carbon monoxide, carbon dioxide, unreacted fuel and *water*.

Not even considering whether the recycle stream is sent to the gasifier or a fuel cell, the recycle stream of hypothetical combination and in the claimed invention are treated in quite different manners.

As seen in FIG. 1, and lines 4-12, page 3 of Farooque, the hydrogen stream is recycled after combining with steam (water vapor) of stream 18. Thus, Farooque teaches to add water (steam) in the stream being recycled, while claim 1 clearly recites removal of water from the recycle stream. Combination with Nakamura does not remove this deficiency, since it is to be placed downstream of the fuel cell, as suggested by the Examiner in the Final Office Action.

Thus, both Farooque and the hypothetical combination teach away from the invention of claim 1.

Thus, the references either alone or in combination do not render obvious independent claim 1, and hence also cannot render obvious the claims depending directly or indirectly therefrom.

C. **Ground of Rejection No. 2:**

The Examiner further rejected claims 1-4, 6-8, 10, 15, 17 and 19 under 35 U.S.C. § 103 (a) as being unpatentable over Ukai in view of Take and Nakamura.



4. **The hypothetical combination lacks features recited by independent claim 1.**

On page 5, point 3 of the Final Office Action, the Examiner formulated another rejection of the claims in view of a combination of Ukai, Take and Nakamura. Of particular interest is that fact that the Examiner did not even argue that the primary reference, Ukai, teaches the claimed recycle stream. Upon close observation, Appellant notes that Ukai does not teach such a recirculation stream. That is, in certain embodiments, residual fuel gas from the fuel cell 1 of Ukai is recaptured, but this recaptured gas is burned. That is, as illustrated in FIGS. 1 and 2 of the reference, for example, the residual fuel gas is returned to a burner 7 that is used to generate hydrogen. However, this residual fuel gas is not purified or separated, and is certainly not returned to the anode inlet.

Just as importantly, the Examiner did not argue that Take teaches such recirculation. Rather, the Examiner simply argued that Take discloses a fuel cell system comprising a hydrogen separator. It is unclear how the Examiner would have included Nakamura in this combination to read on the invention of claim 1. At the bottom of page 6 of the Office Action, for example, the Examiner argued that Nakamura teaches a fuel cell system in which water vapor is removed from exhaust gas. Even if this were the case, this would not teach the recycling of hydrogen following separation of hydrogen, carbon monoxide, carbon dioxide, unreactive fuel and water as recited in claim 1.

Simply based upon the faulty and inadequate formulation of the rejection, Appellant submits that a *prima facie* case of obviousness had not been made out by the Examiner based upon the combination of Ukai, Take and Nakamura. Claim 1 is therefore believed to be clearly allowable over any combination of these references. The claims depending from claim 1 are believed to be equally allowable by virtue of their dependency from an allowable base claim.

D. **Ground of Rejection No. 3:**

The Examiner rejected claims 13, 14 and 16 under 35 U.S.C. § 103 (a) as being unpatentable over Farooque and Nakamura in further view of Sridhar.

Further to rejecting the independent claim 1 as described in section above, the Examiner has added another reference, Sridhar, and used the combination to reject dependent claims 13, 14 and 16:

Sridhar discloses a fuel cell system comprising a carbon dioxide separator to separate the carbon dioxide before the anode exhaust is discharged to the ambient. An adsorption/ absorption based separator is used. See Figure 9, paragraph 93.

See Final Office action, dated 14<sup>th</sup> November 2007, page 7, and point 4

As noted above, the combination of Farooque and Nakamura cannot render claim 1 obvious, since the hypothetical combination is structurally different than the system of present invention. Since dependent claims inherit recitations of independent claims, the combination of Farooque and Nakamura cannot anticipate claims 13, 14 and 16. Combining with Sridhar to include details of carbon dioxide separators does not overcome this deficiency.

E. **Ground of Rejection No. 4:**

Claims 13 and 14 were further rejected under 35 U.S.C. § 103 (a) as being unpatentable over Ukai and Take in further view of Sridhar.

As noted above, a hypothetical combination of Ukai, Take and Nakamura are inadequate to render claim 1 obvious. Dependent claims 13 and 14 similarly cannot be rendered obvious by Ukai and Take. The Examiner used Sridhar to borrow details of carbon dioxide separator. This addition still does not overcome the deficiency of the lack of features of main claim.

Thus, Appellant submits that claims 13 and 14 are allowable over cited combination.

**Conclusion**

Appellant respectfully submits that all pending claims are in condition for allowance. However, if the Examiner or Board wishes to resolve any other issues by way of a telephone conference, the Examiner or Board is kindly invited to contact the undersigned attorney at the telephone number indicated below.

Respectfully submitted,

Date: April 14, 2008

/Patrick S. Yoder/

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8. **APPENDIX OF CLAIMS ON APPEAL**

**Listing of Claims:**

1. A system for co-production of hydrogen and electrical energy comprising:  
a fuel cell assembly comprising a plurality of fuel cells, the fuel cells further comprising a cathode inlet for receiving a compressed oxidant, an anode inlet for receiving a fuel feed stream, an anode outlet in fluid communication with an anode exhaust stream and a cathode outlet in fluid communication with a cathode exhaust stream; wherein at least a portion of the fuel feed stream reacts with the oxidant to produce electrical power; and the anode exhaust stream comprises hydrogen, carbon monoxide, carbon dioxide, unreacted fuel and water;

a separation unit in fluid communication with the fuel cell assembly, wherein the separation unit is configured to receive the anode exhaust stream from the fuel cell assembly to separate hydrogen from the anode exhaust stream, the separation unit comprising a moisture separator to separate water from the anode exhaust stream; and

a recycle stream in which at least a portion of the anode exhaust stream is recycled back to the anode inlet after separation of hydrogen, carbon monoxide, carbon dioxide, unreacted fuel and water.

2. The system according to claim 1, wherein the fuel cell assembly is operated in a low utilization mode, in which the fuel feed stream is consumed at a rate less than or equal to 70%.

4. The system according to claim 1, wherein the fuel cell assembly is operated at a voltage of about 0.7 volts to about 0.85 volts.

5. The system according to claim 1, wherein the mole fraction of hydrogen at the anode outlet is between about 0.1 to about 0.5

6. The system according to claim 1, wherein the oxidant is air.
7. The system according to claim 1, wherein the fuel feed stream comprises at least one fuel selected from the group consisting of natural gas, methane, and a coal derived gas.
8. The system according to claim 1 further comprising a heat exchanger configured to receive and heat the fuel feed stream using the anode exhaust stream from the fuel cell assembly.
9. The system according to claim 1, wherein the fuel cell is selected from the group consisting of solid oxide fuel cells, molten carbonate fuel cells, regenerative fuel cells, and protonic ceramic fuel cells.
10. The system according to claim 9, wherein the fuel cell is a solid oxide fuel cell.
13. The system according to claim 1, wherein the separation unit comprises a carbon dioxide separator to separate carbon dioxide from the anode exhaust stream.
14. The system according to claim 13, wherein the carbon dioxide separator is selected from the group consisting of at least one chemical absorber, pressure swing adsorber, cryogenic separator, membrane separator and carbon dioxide liquefier.
15. The system according to claim 1, wherein the separation unit further comprises a low temperature shift reactor for converting carbon monoxide to carbon dioxide and a hydrogen separator.

16. The system according to claim 15, wherein the carbon dioxide is separated from the anode exhaust stream in at least one location selected from the group consisting of a location prior to the low temperature shift reactor, a location after the low temperature shift reactor and a combination thereof.

17. The system according to claim 15, wherein the hydrogen separator comprises at least one membrane.

19. The system according to claim 1, wherein the moisture separator is selected from the group consisting of at least one condenser, molecular sieve bed and chiller.

9. **EVIDENCE APPENDIX**

None.

10. **RELATED PROCEEDINGS APPENDIX**

None.